Treatment by Saline Infusion:
Its Principles and Practice;
With Illustrative cases.

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Treatment by Saline Infusion lies on the borderland between medical & surgical procedures. Its importance as an adjunct to major Surgical operations has been so much appreciated by Mr Mayo Robson that he has declared that he never performs a capital operation without including amongst his instruments a simple transfusion apparatus, and a packet of salt sufficient for four pints of saline solution. Medically the number of different conditions in which it has been successfully resorted to, and the greater, and continually increasing, number in which, with greater or less reason, it has been recommended, give it, at present, great importance, no matter what the ultimate limits to its application may be. To the general practitioner, inasmuch as the emergencies where its use is most

[1] Med. Annual 1904 p. 44

likely to be satisfactory often arise suddenly, a clear conception of its rôle is most desirable. As a general practitioner the subject of the present paper has suggested itself to me from experience of a few cases with the desire of focussing in my own mind the principles of application, the methods to be adopted, & the particular cases in which its use is advisable.

In medicine generally treatment is most successful when causes – ultimate causes – are clearly recognised, & are removable. After that the recognition and correct interpretation of symptoms, which often constitute themselves proximate causes of further symptoms, is most important, and will lend a key to the adoption of precise & intelligent remedies. Thus a commencing

external hæmorrhage may be arrested by securing the bleeding vessel before faintness becomes extreme, whilst the shock or collapse consequent on severe nervous impressions, or on extreme loss of blood, requires, in addition, that the work of the heart should be reinforced by means of which saline infusion will often prove a potent aid.

Physiological Data.

Saline infusion consists in direct or indirect addition to the blood of a saline fluid approximating in osmotic equivalent to that of the blood plasma. Solutions which have the same osmotic value are termed "isotonic" or "isosmotic". Isotonic solutions of the various crystalloids differ in their degree of concentration; a ·6% solution of Sodium chloride is iso-

isotonic with a 5% solution of Glucose. Isotonic solutions have equal freezing points. Solutions which have an isotonic value equal to that of blood plasma are called normal solutions. 0.7 & .6% is the normal Sodium chloride solution, & is known as normal Saline, or neutral Saline Solution. It is chosen, & is the basis of most infusions into the blood, because Sodium Chloride is by far the largest saline constituent of the blood plasma. When a fluid is wanted (as in intravenous infusion) which more closely approaches the actual saline constitution of the blood as a whole, the following formula is frequently used.

Chloride of Soda	50 grains.	
Chloride of Potash	3 "	
Sulphate of Soda	2.5 "	
Carbonate of Soda	2.5 "	
Phosphate of Soda (Na_3PO_4)	2 "	Sterilized Water 1 Pint.

In all emergencies however & in all cases

where the introduction is indirect the .6%, or normal saline solutions, will be perfectly efficient.

When a considerable Hemorrhage has occurred, or there has been any large drain of fluid from the system, it is easy to understand that substitution by fluid from the outside may be quite reasonable. As we shall see there are many other conditions in which the procedure is adopted.

The blood is a fluid which is having continually added to it nutrient material, the products of digestion, and Oxygen from inspired air. It is constantly exchanging these for effete materials of the metabolic process, which are expelled by the various excretories. Thus its composition varies in different parts, and at different times; yet the balance of exchange is so nicely managed by the regulative nervous mechanism

that the total variation, both in quantity and in quality, is within very narrow limits, and an increase in the uptake of fluids from the alimentary canal is speedily compensated for by a corresponding increase in the excretion of urine, etc. This is brought about by variations of the local blood pressure. On the other hand, when the intake from the usual channel is deficient the volume of the circulating fluid is made up by calling upon the reserve which exists in the various tissues, and physiologically this process can go on to a considerable extent. The volume of the blood, then, is maintained at a practically constant figure. This was long ago estimated at 1/13 of the body weight, by bleeding thoroughly, then mincing the tissues, and extracting the remaining blood from them, and comparing

calorimetrically with a standard solution of blood from an artery. More recently Haldane & Lorrain Smith[1] by means of partial saturation with Carbonic Acid Gas have made a more careful estimate, & place it between 1/16 & 1/25, generally about 1/20, of the body weight. This, in a fourteen stone man, means about ten pounds in weight, or somewhat over a gallon in volume.

That trifling losses of blood are easily recovered from is a matter of common experience. About one fourth of the total blood quantum can be withdrawn without lasting fall of blood pressure[2]. The blood is sent through the system at a certain rate which is conditioned by the force & frequency of cardiac action, by the capacity of the vascular system, & by the peripheral resistances. The last

[1] Journ. of Physiol. Vol. XXV p. 331

[2] Schmiedeberg's Arch. f. exp. Pathol. & Pharm. Vol. XXXVIII p. 427.

mentioned factor is the result of the tonic contraction of the arterioles, and the viscosity of the circulating fluid.

Cohnheim's observations go to shew that the capacity of the vascular system is much in excess of the normal requirements, and that the amount of the circulating fluid can be increased enormously without permanently increasing the blood pressure. First of all in transfusion of blood, or the injection of defibrinated blood, it was found that up to 50% of the total originally contained in the body could be added with rise of pressure only at the moment of injection, a fall to the normal occurring in a few minutes. The amount of blood could even be doubled without permanent change of blood pressure, and Wm Miller concluded that 150% addition is the

[1] Cohnheim's General Pathology. p. 417.

outside limit beyond which life is directly threatened. When blood pressure was low to begin with, (obtained by previously bleeding the animal) it was found that injection led to a speedy rise of pressure to the normal, and thereafter the course of experiment was as before.

The injection of blood from an animal of a different species was tried, but with disastrous results, being followed by diarrhoea, dyspnoea, loss of appetite, and various hemorrhages, all pointing to destruction of blood corpuscles. The blood serum of one species is toxic to the corpuscles of another[1], although the resisting power in each species is greater for some than for others, the practice of injecting foreign blood is unphysiological. Incidentally it may be noted that Von Bier[2], with a perfect appreciation of these facts, observing that

1. Cohnheim. Gen. Path. p. 439.

2. Mid. Annual 1903. p. 440
Brit. Med. Journal. 1901. II. p. 100

cases of recovery were followed by reaction with hunger, thirst, and increased metabolism, has recommended the injection of defibrinated Sheep's blood in cases of Tuberculosis. The injection of blood from another species being proved a fallacy, and, keeping in view the difficulty in treatment of disease of obtaining human blood, not to mention the actual dangers of direct transfusion from coagulation & embolism, Cohnheim's further observations on the injection of saline fluid are interesting and important.

He & Leichtheim repeatedly injected solution equal to five or six times the normal blood quantity without any untoward symptoms appearing, and without raising the blood pressure until nearly the end, which was heralded by considerable oscillations of blood pressure. But a point to be noticed in these saline

1. Cohnheim. Gen Path. pp 435 & 724

infusion experiments is that, although the blood pressure was not raised, the Velocity of the blood stream was much increased, and that not only during the injection, but for a considerable time thereafter, as was observed microscopically in the tongue & swimming membrane of a frog. This was due to the diminished viscosity of the blood, and the consequent decrease of resistance in the capillaries. These observations are of practical importance as shewing:-

(1) The considerable percentage of blood which may be lost, and recovery ensue.

(2) The large amount of fluid which may be added without inconvenience from raising of blood pressure.

(3) The means, in the increased Velocity of flow, by which the oxygenating power of a diluted blood is brought up, approximately, to the requirement of the tissues

Further, bearing in mind that uptake is ultimately, if not immediately, balanced by excretion, we see in infusion a means of washing the blood, so to speak. Considering, also, the relatively huge amount of fluid which can be accommodated, and the speed with which it is got rid of, may the disappointing results of saline infusion as a therapeutic measure sometimes complained of not arise from timidity in its application? Infusion of a larger amount, or repitition of the treatment, might, in such cases, carry matters on till the natural forces could assert themselves to advantage.

Reverting for a moment to our perhaps inadequate definition of saline infusion, it will be observed that the experiments cited are illustrative of what we have called direct addition to the blood. In the physiological process after less degree of haemorrhage, in the

absorption of fluid from serous cavities, and from the cellular tissues in oedema, we have demonstration of the indirect modes by which fluid may be added to the circulation - the usual absorbent channels & reservoirs.

Indications

What, then, are the indications for saline infusion? Broadly they may be divided into two main classes:-

I. Depleted Blood vessels.

II. Conditions where certain poisons circulate in the blood.

I. Depleted Blood vessels. This term includes a great variety of conditions.

1. Firstly, and most obviously, there is severe haemorrhage, whether external, the result of accident or of operations performed; or internally, as in the bleeding of an eroded gastric vessel or in ulcerated bowel; or we partaking partly of the

nature of both, as in abnormal bleeding from the uterus, when the blood may be expelled or retained. In all these cases the blood as a whole is lost to the system.

2. Secondly, there are those conditions in which an excessive amount of fluid is suddenly withdrawn from the system, as in Cholera, Dysentery, severe infantile diarrhoea, and profuse vomiting.

3. Thirdly there are the conditions of Shock, and collapse, which, indeed, will be initiated by any of the foregoing conditions, but which may arise otherwise, and ~~in~~ which, whilst there may be no external loss of blood or fluid from the body, are characterised by an abnormal distribution of the blood, whereby a considerable amount is withdrawn from the circulation.

II Conditions where certain poisons circulate

in the blood. The conditions coming under review here are of a less easily defined class, inasmuch as the causes are, in many cases, still subject of conjecture and theory. They may all, however, be summed up in the term Poisoned blood. The poisons may be put into the following classes.

1. Those elaborated in the body, and retained therein by defect of excretion, or produced, and circulating in the blood as a defect of metabolism. E.g. Uræmia & Diabetic Coma
2. Those produced as the result of the action of bacteria introduced from without, & comprehensively labelled as due to Toxins.
3. Those the result of the actions of poisons commonly so called, such as Opium, Morphia, Carbonic acid and Coal gases, Chloroform Vapour, &c., &c.

In grouping these conditions we have said

that in the first group of cases Shock & collapse will ~~to~~ be present. The same remark may be extended to many of the conditions of the second group, a diminished or a vitiated circulation in the nerve centres being capable of producing similar results. So much is this so that considerable illumination as to the rationale of saline infusion is obtained from a consideration of the symptoms, causation, and pathology of Shock and Collapse.

The Symptoms of Shock and collapse are very similar. The patient is prostrate, semi-conscious, and generally capable of being roused. The face is pale and drawn, the eyes sunk, and the cheeks hollow. The skin is cold and damp, and the temperature may be subnormal. Cardiac action is rapid & weak; the pulse irregular, feeble, & fluttering, and there is cyanosis. The mouth and tongue are dry; there is

thirst. The urine is diminished: there may be anuria.

As to Causation there is an essential distinction to be drawn, though it must always be remembered that in many cases there will be the elements of both shock and collapse, which may be so fused as to be practically inseparable. Broadly speaking Shock involves essentially a nervous element - central or peripheral in origin - which is wanting in collapse, and which is suddenly produced in those who previously were comparatively healthy persons. Thus shock may be caused by purely mental emotions. Injury, which need not in itself be very great, of abdominal organs or of other specially sensitive parts such as the testicle, or which cause great pain, as in the crushing of a finger or in severe, & especially in superficial burns: the nervous impressions caused by passing gallstones, or renal or cystic calculi:

perforation of the stomach or intestine: strangulation of hernia; rupture of the bladder or uterus: the formation of a pneumothorax*: these all are familiar causes of shock. Direct injury to the brain too, as illustrated in concussion, whose symptoms are practically those of shock plus greater unconsciousness, may be cited. All these illustrate the sudden (time) and the nervous elements in the causation of shock.

Collapse on the other hand occurs more insidiously, and generally in a patient already the subject of disease. The cause may be written generally as large & rapid loss of fluid, such as occurs in profuse hæmorrhages, severe diarrhœal conditions, the sweating of heatstroke &c. The most marked examples occur in the algid stage of cholera, and in the diarrhœa of young children.

Pathology of Shock. The earliest writers on the

* British Medical Journal 1899. I p. 1292

subject were Clowes, Surgeon to Queen Elizabeth, and Wiseman, Surgeon to Charles II., but the first adequate description is that of John Hunter, in 1784, followed by Travers on "Irritation" in 1826. There are two chief theories (I) the Vascular & (II) the Nervous

I The Vascular. Fischer recalls Goltz's experiment whereby from a smart blow on the tapped stomach of a frog the heart is arrested in diastole, and there is stagnation & excess of blood in the abdominal veins. Schneider Expanded this, and said that Vaso-motor paralysis involved the whole Vascular System, whilst Marcel Mouillin advanced a step further and asserted ~~that~~ "A reflex inhibition affecting all functions of the nervous System, and not limited to the heart and vessels alone." This latter idea gave explanation of the observation made by Hunter of bright blood issuing

[1] Lazarus-Barlow. Gen. Pathology. p. 695

from a vein in a patient suffering from shock. Brown Sequard, investigating the condition came to the conclusion that it depended on an "inhibition of exchange".

II The Nervous. Sir Astley Cooper ascribed the symptoms to direct or indirect action on the nervous system; Groningen to a swift overwhelming of the whole spinal cord by a sudden intense stimulation from the periphery

A recent and exhaustive study of the whole subject was published by George W. Crile[1], the result of 148 Experiments. He concluded that the condition was due to impairment and breakdown of the vaso-motor mechanism. There is either total paralysis of the vessel walls or its equivalent. The heart is not exhausted, and is proved not to be the principal factor in the production of shock.

[1] An experimental research into Surgical Shock. 1899.

The truth is that there is greater divergence in mode of expression of these various theories than in the conception of the series of events, for the vascular and the nervous phenomena are so inter-dependant, the relations of cause and effect are so close & interchangeable, that the various ideas can readily be reconciled with each other.

The elements of shock are cardiac and vascular disturbances induced by nervous impulses of central or peripheral origin — that is, either direct or reflex

1. There is dilation of the peripheral arterioles, more especially in the Splanchnic area, leading to fall of blood pressure. Here we reach the first consideration coupling up our subject of injuries with shock
2. There are reduced intake and output at the heart, further reducing blood pressure, and, by comparison —

anaemia, further affecting the nervous system in common with all other parts.

3. According to Roger, following Brown Sequard, arrest of Exchange is constant and indispensable. Thus explains the delayed, but afterwards dangerously powerful, action of drugs such as Opium, Strychnine, &c which may have been used during shock.

4. There is inhibition of all the functions of the nervous system, not confined to the vascular alone

Pathology of collapse. Here we have to do with the condition following loss of large quantities of blood, or of fluid derived from the blood, or an abnormal distribution of fluid such as occurs after abdominal operations, and in peritonitis. The blood and the solid tissues lose water so that the blood becomes thicker (Tarry)

and the tissues drier, whilst in both the specific gravity rises. These conditions have been investigated Experimentally.

Sherrington and Copeman[1], though speaking of the condition as "Shock", found that, on opening the abdomen and disturbing its contents, the specific gravity of the blood rose.

Roy & Cobbett[2], in more complete and detailed investigation, traced out closely the steps of the process, dividing it into three periods. The animal in the course of the Experiment was under the influence of an anæsthetic to avoid Shock.

1. In the first period the specific gravity of the intestinal wall diminished, whilst the specific gravity of the voluntary muscles rose, but that of the blood remained normal. There was alteration in distribution of lymph, the blood parting with some to the injured tissues,

[1] Lect. Barlow. Gen. Path. p. 649. [2] Allbutt. Syst. of Med. Vol III p. 327

and making up its loss from the healthy parts. In this period the blood pressure remained undisturbed, since its loss and gain were balanced

2. In the second period there was no further rise of specific gravity in the muscles - they becoming drained of their fluid - but the specific gravity of the blood and its viscosity increased, the drain from the blood to the injured tissues continuing.

3. In the third period the pulse gradually became more rapid, blood pressure began to fall, and death speedily ensued.

Deductions from these observed facts. The drying of the tissues, and the inspissation of the blood with its diminished viscosity in Collapse, are direct indications for the addition of fluid by saline infusion.

In Shock perhaps more importance has to be paid to stimulation of the heart, and alcohol

and other stimulants are most useful; but here also saline infusion is to be recommended in that as the right side of the heart is empty, or imperfectly supplied with blood, infusion, especially direct intravenous, will be a powerful stimulant to its action, which, not aerated, although by an indifferent, and non nutrient fluid, will by the study admixture of that fluid with the existing contents of the blood vessels, bring the whole to a workable condition.

The history of operations for adding fluid to the blood is buried in the mists of antiquity. It is supposed to have been practised in Ancient Egypt. The first definite account we get of it was in the case of Pope Innocent VIII in 1492. Thereafter the procedure had fallen into abeyance, at least records are wanting, until the 17th Century

when we read of dispute between
French & English practitioners as to
priority in performing the operation of
transfusion of blood. The outcome of
discussion seems to be that it was first
suggested & experimentally performed in
France in 1657, but as a human Therapeutic
measure was resorted to first in England
in 1666. The use of Saline fluid was
first made in the treatment of cholera
early in the last century. Goltz Experi-
ments showing that in loss of blood death
was due to unfilled vessels, & that any
harmless fluid would serve to replenish it,
& W. Hunter's observation that transfused blood
was efficient only by virtue of its raising
blood pressure, have made Saline Solution
in every way favourable.

In its nomenclature Saline injection
has suffered from a want of accuracy
only too common in medical philology.
It is variously spoken of as transfusion, per-

1. Lancet 1874. II p. 529.

fusion, infusion, and injection. Enteroclysis and Hypodermoclysis are terms used to denote introduction by the rectum and under the skin respectively. The term transfusion has survived from the now obsolete operation of direct transfer from the circulation of one to another, and might fittingly be reserved for descriptions of that operation only. Injection seems to connote an element of force in the introduction which, in actual practice, it is well to avoid. On the whole the term Infusion is perhaps the most fitting, and it can easily be qualified by the necessary adjectives.

We describe four methods of infusion.

1. Intravenous. Direct introduction to the blood stream through a superficial vein.
2. Hypodermic. Introduction into the cellular tissue under the skin.
3. Rectal. Introduction into the large bowel

4. Peritoneal: as is often done in abdominal operations.

Intravenous infusion is the most direct, the quickest in action, and the most powerful in effect, but also the most transient in result. It is the oldest method, following naturally upon blood transfusion, and, if we may so put it, it is the most surgical in execution. It is the method to be adopted in sudden and clamant emergencies, especially on the operating table with its aseptic surroundings, and its skilled and adequate assistance. The median-basilic vein is the one usually chosen, and is exposed as for venesection. The usual apparatus required are a cannula for introduction into the vein, a length of tubing - three or four feet - to connect the cannula with a reservoir capable of holding one or two pints of fluid,

at a temperature of between 100° & 110° F.
A useful addition is a clip to the rubber
tubing which can be made to exert
varying pressure on the tubing, so as to
regulate the rate of flow, or entirely
suspend it should indications for so
doing arise. The fluid is run in at
a pressure of about two feet. It has
been well suggested that the cannula
should be cut off straight at the end,
& not bevelled as it usually is, since
trouble is sometimes caused by the
wall of the vein blocking up the
oblique opening in the latter case.
The whole apparatus should be boiled
previous to use, the area of operation
thoroughly disinfected, and every
precaution taken to ensure perfect
asepsis in the course of the infusion.
The special danger of this method —
after the risks of sepsis — is the
entrance of air into the vein. This

danger has perhaps been exaggerated, since air in the veins is practically harmless unless in large quantity, several cubic centimetres being necessary to kill a dog. By properly maintaining the level of the fluid after injection has begun the danger will be obviated. The critical moment is that of introduction of the canula, and Julian y. Cunilla[1] has suggested an improvement on the ordinary method of double ligature. He uses a triple ligature which seems perfectly to meet the case, besides allowing the operation to be done more deliberately. First a distal ligature is applied, and tied firmly at once; a middle ligature is put in position, and left untied; a proximal ligature is introduced, and tied with a slip knot. Then an

[1] New York Med. Journal, May 27 1899

incision is made between the distal and middle ligatures, and the canula, with solution flowing, is introduced. Fluid flowing through the canula cannot get past into the vein, since the proximal ligature on a slip knot intervenes, but in its flow it expels all air from the wound area, and from the small section of vein implicated. Whilst the flow is going on the proximal ligature is slipped, and the # middle ligature is secured firmly round the canula.

The drawbacks to this method in general practice are the necessity for rapid asepsis, and the difficulty of obtaining the assistance which is necessary for its deliberate performance.

Hypodermic Injection. Saline with

Skin lying loosely over the subcutaneous tissue is chosen, and a sharp pointed canula, with a calibre somewhat larger than that of an ordinary antitoxin needle, fitted up with tubing and reservoir as in the former method, is plunged at the latter. Before insertion the fluid should flow freely through the apparatus to expel all air, & should be flowing when the needle is inserted. Suitable sites are under the Mammæ below the ribs, between the shoulder blades, in the anterior fold of the axilla, or in the flanks. Since the introduction here will necessarily be slower, means must be resorted to for maintaining the temperature of the injected saline. This may be done by having the reservoir of sufficient capacity to allow of frequent small quantities of fresh fluid being added

to it, or by allowing the tube through which the saline flows to be immersed in a vessel of fluid maintained at a suitable temperature. Asepsis of the apparatus, and of the area of skin involved must be secured. Large quantities of fluid can be introduced thus, and absorbed with a speed which makes the method nearly as efficient as the intravenous, and is to be preferred in those cases in which there is right cardiac embarrassment. Since the fluid is absorbed at what we may call a physiological rate there is not even the momentary raising of blood pressure which occurs with intravenous infusion. A pint may be injected under each mamma, and as much as four quarts have been injected at the axilla. Tension should not be allowed to become extreme. Gentle

massage of the part is of great assistance, and when tension becomes as great as is desirable, the needle can be withdrawn and inserted in a fresh area.

Apart from sepsis, the chief danger is that of slumping from extreme tension, or the formation of haematoma from injury of a bloodvessel. The latter accident under aseptic precautions is of little moment, but otherwise abscess may result.

Rectal Infusion is the method which is perhaps most useful in private practice, with its varying emergencies, and necessity for working single handed. Lépiné of Lyons concluded that rectal infusion was quite as efficient as subcutaneous, absorption by the mucous membrane taking place as readily as from the cellular tissue, and, what is after all the important practical

1. British Med. Journal. 1899. II p. 672

point, the clinical effect was the same and appeared as quickly. It is to be recommended in that there is no breach of the tissues as in intravenous or hypodermic injection, and so the danger of sepsis is avoided. There is no call for the surgical facility necessary when the venous route is chosen, nor is there any danger from air embolism. The risk of overdistension of the tissues which occurs in the hypodermic method is avoided, and the amount of fluid which can be immediately introduced is greater. The composition of the fluid can also be altered to suit any special indications of the case, and in ordinary cases a rough and ready mixture of one teaspoonful of table salt to a pint of water is all that is necessary. The temperature of the fluid can be varied very

largely without damage to the tissues such as would occur by the other methods, and this is a distinct advantage to the rectal route. On the other hand very warm injections (110°-125°F) exert a particularly stimulating, diuretic, and diaphoretic action, whilst cooler or quite cold fluid may judiciously be used in combating highly febrile conditions.

There is no danger of too much fluid being injected and injuring the bowel by overdistension. Before that occurred the sphincter would give way or the ileo-cecal valve would allow passage into the small intestine. No matter how much fluid may be introduced into the bowel the circulatory system will take up only such amount as it can deal with, and as the condition calls for. Then,

Should any necessity arise for recalling the infusion - as by reason of untoward action - it is possible to do so from the rectum, but impossible after intravenous or hypodermic infusion.

An important recommendation is that this method may be used in conjunction with any of the others, and very often is most useful in keeping up the effects of the first non-direct infusion.

Finally, the apparatus necessary for rectal infusion can very readily be improvised from material most likely to be at hand than in the other cases.

All that is necessary is the way of apparatus is a short piece of some fat bore of India-rubber tubing, and a funnel connected therewith into which to pour the fluid. The

tubing should be sufficiently rigid not to collapse under pressure of the sphincter, and about 1/4" or 3/8" bore. It is an advantage to have it's end solid like that of a stomach tube with the opening at the side, so accidental blockage by feces is thus less likely. In young children a large sized rubber catheter (No 10 or 12) will suit admirably. Or the infusion may be given by means of an ordinary Higginson's Syringe with a length of tubing fixed over the ordinary bone nozzle - tubing from a binaural stethoscope has been made to serve this purpose. Or, as the writer has done on occasion, the nozzle may be unshipped, and the tube in the distal end of the bulb be itself introduced. The tubing is passed about eight

niches through the rectum into the sigmoid flexure, and, with the funnel raised about two feet, the fluid is allowed to flow in slowly. When a Higginson Syringe with a length of rectal tubing is used it will be found that after the flow is established it will continue by siphonage if the containing vessel is raised. The apparatus should be filled with fluid prior to starting the infusion, to avoid the entrance of air into the bowel. The patient may be on his back, or on the left side, but the hips must be well raised. Fortunately this is a position which in itself is desirable in conditions of shock and collapse. The infusion may be begun with the patient on his left-side; as it proceeds he is gently turned on his back, and finally

as to his right side. In this way it is possible to fill the colon to a very great extent. As much as a couple of quarts can readily be injected per rectum.

Intra Peritoneal Infusion is to be used only as an adjunct to abdominal operations, in which it is very useful It has been recommended in ordinary cases but the dangers of peritonitis, of injury to abdominal organs, and of shock are too great to make it worthy of consideration as against the other methods at our disposal. It has been objected to even in cases of abdominal operations from a consideration of the slowness with which effusions are absorbed from the peritoneum and other serous cavities, but it should be remembered that these effusions consist of highly albuminous material, depending for its absorption mostly on the

lymphatics, whilst normal saline solution in virtue of its osmotic power is rapidly absorbed by the blood-vessels. It has been estimated that the peritoneum can absorb from 3% to 8% of the entire body weight per hour.[1]

The Effects of saline infusion, whatever the method chosen, are speedily apparent in the improvement of the patient's condition. In cases of shock and collapse, from whatever cause, where the pulse has been rapid, feeble, irregular or perhaps altogether inappreciable, and the cardiac action weak & fluttering, there is speedily recovery in these respects. The cardiac impulse becomes regular in rhythm, and from its force, the pulse correspondingly improves, and the blood pressure rises. Colour returns to the face, and the elements constituting the "Facies Hippocratica" gradually disappear. Lilythay gives

[1] Brit. Med. Journal 1901. II p. 981

place of interest by the patient in his surroundings, an interest which may, unfortunately, mean appreciation of present discomforts, but which is a welcome change from an oblivion but slightly removed from death. Much of the improvement may be only temporary, but, however temporary, it should form a stimulus to perseverance in a means of treatment which tends to make it permanent.

The remote effects are the production of profuse diaphoresis and diuresis, the bulk of the fluid being eliminated by the skin and kidneys in a very few hours. In connection with the urine Prof W. H. Thompson[1] found experimentally:

1. Marked increase of Urine secreted reaching a maximum in the second hour after infusion, and not wholly subsiding in four hours.
2. That both the total amounts of Nitrogen

[1] Brit. Med. Journal, 1899. I p. 793.

and of Urea were also increased, reaching a maximum the hour after injection, and,

3 That in many cases the actual output of Chlorides was diminished.

The clinical effects appreciable in the improved condition of the patient are warrant of the utility of filling up depleted blood vessels to tide over a crisis; and the observations of Prof Thompson are similarly conclusive of rational procedure in the attempt to eliminate poisonous material from the blood.

As regards the quantity of fluid which should be injected no certain rules can be laid down - it will depend on the emergency which has to be met, and on the response which the patient makes to the treatment. When the subcutaneous or the rectal route is chosen

the amount does not require to be gauged so carefully since the tissues will not absorb greater quantity than they can deal with. It is otherwise when ~~intra~~ intra venous or direct infusion is practised, and the amount infused should be proportioned to the amount of blood which has been lost, and the effects on the pulse should be carefully watched. The injection should be made slowly so as not to flood the right side of the heart. Any signs of embarrassed right heart, such as cyanosis, distension of veins on the opposite side, irregularity or slowing of the pulse, with a sense of oppression on the chest should the patient be conscious, will be indications that infusion has proceeded far enough for the time being.

Existing disease of the Lungs should be a reason for special care, some writers averring that infusion is liable to lead

to Edema. - But, since blood pressure is not raised for any length of time the danger is not great, and, if need be, may be minimised by forcing bleeding. On the other hand, as we shall see later, infusion is with good reason specifically recommended in certain cases of Pneumonia. In all cases it should be remembered that saline infusion means diluted blood, diminished viscosity, and also diminished coagulability. It is therefore important that where possible hæmorrhage should be completely & permanently arrested, & that where this is impossible or uncertain, as in Hæmatemesis, bleeding from enteric ulceration, &c., infusion should be carried no further than is necessary to overcome urgent symptoms.

We have already hinted at the fact that Normal saline solution can be made the

basis for introduction of other substances into the body which may be expedient in the particular case. Thus at times brandy, liquor strychninae, and ammonia are sometimes used as stimulants in conditions of shock and collapse. So also additions may be made to produce more definite remote effects, as of bicarbonate of potash or sodium acetate to increase diuresis in the treatment of Eclampsia. Adrenalin is sometimes added, too, for its hemostatic effect in hemorrhages which cannot be directly attacked. Then in ~~combating~~ combating toxic conditions the possibility of introducing antidotes must be kept in view. The use of bicarbonate of Soda in Diabetic Coma with the idea of neutralizing the Beta oxybutyric acid which is the supposed toxic agent is a case in point. As our knowledge of the nature of the

poisons in various toxic conditions becomes more accurate we may hope to devise and to apply more direct antidotes.

The infusion of a weak solution of glucose is mentioned by Lazarus Barlow[1] as being theoretically of considerable nutritive value, and Mr. Arthur E Barker[2] F.R.C.S. has published a suggestive paper on the use of Saccharo-saline infusions in exhausting diseases. It is necessary in making other crystalloid additions to have regard to their Isotonic value, and to make their solutions of isotonic normal proportions otherwise disastrous effects may ensue in the tissues. The use of carbo-hydrates in this manner would of course be contra-indicated in cases of diabetes.

Saline solution may also be made the vehicle for introduction of drugs. Gaspero[3] found that the sedative action of such

1. General Pathology, p. 708. 2. Brit. Med. Journal, 1902, I p. 770
3. Medical Annual, 1904. p. 21

remedies as duboisine, hyoscine, and bromides was greatly enhanced when given hypodermically with 400 c.c. of saline solution. The effect produced with the solution was equal to that of double the dose given without.
The effects of saline solution infusion are sometimes enhanced by the use of depletion at the same time. Thus bleeding in diabetic coma, or in uræmia will directly withdraw a certain amount of toxic material from the blood, and the saline infused will dilute to a greater degree what is left, and will more readily effect its elimination. So also in Eclampsia, after delivery it is good practice not to arrest convulsions too speedily, on the assumption that the nervous storm has been the result of toxins in the blood, and that the bleeding will drain a certain amount directly away. In other cases

diuresis, diaphoresis, rehmunations
from the bowel should be encouraged
on the same principle.

It is now proposed to pass in review (briefly) the records of certain cases in which saline infusion has been resorted to, & opportunity will be taken to emphasise, when necessary, the points already considered, and to introduce such others as may be suggested. It should be premised that investigation into the literature has been necessarily limited by the exigencies of practice, & that the writer's own cases, though striking, are few in number. It may be useful to make this survey in somewhat the same order as that of the indications for saline infusion which we have made.

Surgical shock. In abdominal operations accompanied, or liable to be accompanied, by great shock saline infusion by each and all of the methods which we have described is regularly carried out. This

is done during operation to minimise, and after operation to overcome shock; and is some cases is resorted to before operation as a preventive measure.

Mr George A. Hawkins-Ambler[1] in a paper on "Shock in abdominal operations", after a close survey of the pathology of the subject, emphasises the value of saline infusion. In the absence of septic conditions he advises the frequent flooding of the peritoneum with the saline, and, recognising the importance of inspissation of the blood as expressed in the extreme thirst of the patient, and the continuance of that dried condition for a time after operation recommends instilling a pint of saline fluid into the peritoneum before closing it up. There is a gain immediately from stimulation of the sympathetic, and ultimately from absorption of the saline which is in

[1] British Med. Journal, 1907 - II p 957

excess of any loss due to peritoneal disturbance. He cites G. Wagner as having shewn that the peritoneum will absorb 3% to 8% of the entire body weight per hour. The effect of this treatment is subsequently to be kept up by saline infusion per rectum, and if that be rejected by infusion into the cellular tissue beneath the mammæ, or below the clavicle. More urgent cases are treated by intravenous infusion, and due attention is paid to other indications in the way of treatment. e.g. warmth of the operating room & operating table; such. * minimum disturbance of the peritoneal contents both in degree and in time as is consistent with the requirements of the case. Incidentally it is pointed out that deprivation of fluid before operation should not be greater than is absolutely necessary

In anticipation of shock Mr B.G.A. Moynihan[1] recommends, in addition to hypodermic injection of strychnine, the infusion of ten, fifteen, or twenty ounces of hot saline solution per rectum before operation, and, after the patient is under the anæsthetic, an infusion of one to four pints is begun.

A class of cases in which infusion is specially indicated is pointed out by Mr W.H. Brown, F.R.C.S.I.[2] namely, those suffering from the effects of prolonged bleeding. Such, for example, is the case of a woman with a bleeding myoma, with whom a long course of palliative treatment has proved futile, & who, with vital forces at the lowest ebb, at last submits herself to a major operation. He advises the intravenous infusion of about five pints of saline coincident with the progress

1. Brit. Med. Journ. 1899, II, p. 1671 2. Ibid, 1901, II p. 1138

of the major operation, and claims that in this way shock is reduced to a minimum. The infusion being under the control of an independent operator both it and the primary operation can be carried out more deliberately and safely.

Hemeter[1] also advocates saline infusion in abdominal operations, and instils as much as two quarts into the peritoneal cavity. In cases where this cannot be done (as in Vaginal Celiotomies) the infusion is made subcutaneously into the loose tissues of the axilla, when, with gentle massage, he has been able to introduce three or four quarts. Or, in emergency, the infusion is made rectally; with the patient in the Trendelenburg position the Sigmoid and the Colon are filled with fluid without interference to operative work

1. American Journ. Obstet. Oct, 1902

Extreme Hæmorrhage affords opportunity for the rational use of saline infusion and many cases are recorded. In the Post partum form it may meet the general practitioner at any unexpected moment. The writer has experienced of two such cases, in which rectal infusion undoubtedly saved one, and was an efficient aid in the treatment of the second.

The first case was a primipara in whom the second stage of labour was very prolonged, the os being fully dilated for twelve hours, the patient persistently repressing forceps either with or without Chloroform. The pains ultimately became very weak, and at last forceps were applied without Chloroform. Delivery was effected easily, and the uterus contracted satisfactorily. About twenty minutes after delivery a

most copious hemorrhage occurred, and the patient collapsed. In the rapidly pinching features one could almost see life ebbing away. The pulse became imperceptible at the wrist. The uterus was found uncontracted, and filled with clot. This was cleaned out and, under pressure with one hand in the uterus and the other on the abdominal wall, contraction was induced. Leaving the uterus in charge of the nurse, hypodermic injections of Strychnine Brandy and Digitalin were administered, but so far with no beneficial effect. A quantity of warm water, estimated at two quarts, which had been brought for washing purposes being at hand, a tablespoonful of ordinary table salt was speedily dissolved in it, and the major part of the fluid was injected per rectum by means of an ordinary

Higginson's syringe with the bone nozzle removed - the hips being well raised. This was retained, and in a few minutes improvement was apparent; the pulse became perceptible and gradually fuller, and the patient regained ordinary consciousness. She was kept absolutely quiet, and in about two hours a further infusion of 1½ pints of warm saline was given. Recovery then (after was uninterrupted.

The second case was not quite so severe. On arrival the porter found the patient lying huddled up on the floor having been precipitately delivered. The placenta was partially detached, and bleeding, which had already been profuse, was still going on. The placenta was speedily expressed, on which bleeding stopped, and the patient was lifted

sisted, and rectally injected with a quart of hot saline having two teaspoonfuls of salt dissolved in it. A hypodermic injection of Cornutin was given, and later one drachm of Ext. Ergotæ Liq. by the mouth. Recovery was uncomplicated. In this case there was a history of great hemorrhage at former previous confinement.

The late Prof. Leuchman[1] writing of post partum hemorrhage refers to Saline infusion. The formula of Dr. Little is recommended, and a repetition of the infusion if there be flagging after the first rally is advised.

The Hemorrhage of Abortion in extreme cases may be treated on the same lines.

Hæmatemesis. A case is reported by Dr. G. A. Stanley Thomas[2] of recovery on resort to Venous infusion after rectal infusion

[1] System of Midwifery 4th Ed. p. 481. [2] Brit. Med. Journal. 1900-I. 1085

had failed. The patient had had repeated and copious hemorrhages D. Bruce Porter[1] reports an extreme case in a female treated by venous infusion of one quart of saline fluid with recovery. The circulation was so depressed that bandaging above the elbow made no difference in the appearance of the vein which looked like a strip of leather.

Discussing this subject D. Burney Yeo,[2] speaking regarding of transfusion points out the risk of increasing blood pressure which may lead to a recurrence of hemorrhage. In saline infusion, with diminished viscosity of the blood, this danger will be aggravated. Care is therefore necessary to infuse as small a quantity as will meet the case.

Cholera. Intravenous saline infusion is a

[1] Brit. Med. Journal 1902. I. p 770.

[2] Clinical Therapeutics, 1894 p 124

mode of treatment of this disease as old as the history of Cholera in Europe, and whose utility is established: Even if somewhat disappointing in the relative number of ultimate recoveries, the remarkable way in which cases on the verge of death have been rallied time after time by repeated injection gives encouragement for its use in the most hopeless cases.

Prof. Cantani of Naples was the first to employ Enteroclysis and Hypodermoclysis.[1] The former is not saline injection as we are discussing it, but an irrigation of the bowel with an astringent, sedated fluid containing Tannin & Opium. Cantani's formula for subcutaneous injection was 2½ ounces of Sod. Chlorid, and a drachm and a half of Sodium

1. Starr's Diseases of Children pp. 268.

carbonate, dissolved in two quarts of boiled water. This appears to the writer to be too concentrated a solution, and the condition would be better met by the ordinary intravenous solution. This, largely practised in Hamburg consists of six parts Sodium chloride, to one part Sodium bicarbonate in one thousand parts of water. The subcutaneous method is slower in its action, but more permanent in its effects; the intravenous is quicker & more suited for rapidly sinking cases. The two of course may be combined.

Recently Mr R.H. Cox, F.R.C.S.[1] of Shanghai recognising the frequency of only temporary benefit by injection as ordinarily practised, has devised a method of continuous intravenous injection whereby an ounce of saline

[1] Brit. Medical Journal, 1899. I. p. 297.

fluid is infused per minute under a pressure of two and a half feet of water column. In one case this method was pursued for four hours, and he believes that by its use in the early stage the mortality may be reduced from 50% to 15%

Dysentery In the treatment of dysentery antiseptic and astringent rectal infusions are more frequently employed than those of normal Saline solution, but many cases have been successfully treated by means of simple Saline infusion. It is recommended that the fluid should be very hot or quite cold, and that the tube should be passed as high as possible and the fluid allowed to run in very slowly. At least one and a half pints should be administered, and may be repeated two or three times a day.

" British Med. Journal 1902 - I p 199

Infantile Diarrhoea. In this condition the writer has had occasion to observe beneficial effects from irrigation with warm saline fluid during the past Summer. It is specially useful in collapsed condition which the writer believes to be due as much to toxic material being continually reabsorbed from the bowel as to the actual loss of fluid from the blood. In young children from half to one pint was injected rectally, and in many cases this was speedily rejected. In some however it was retained, & its beneficial effect on the pulse was soon perceptible. Even in those cases where the infusion was speedily rejected, some part would be retained, & the rejected portion was no doubt useful in washing away quantities of toxic

material which, under ordinary circumstances, would have been reabsorbed. The retained portion would have a stimulating effect by making up for lost fluid, and would tend to dilute the toxic fluids.

Puerperal Eclampsia. Numerous cases have been reported of benefit from infusion in this condition. Much of course can and should be done in the way of preventive treatment, but there are cases which very often are first brought under notice when symptoms are clamant and treatment must be prompt. Allen[1] reports three cases treated by repeated infusion with recovery, and, in summarizing the treatment of the Eclamptic stage, recommends Morphia hypodermically & Chloral hydrati or Potass Brom. rectally.

[1] Amer. Journ. Obstet. Obstet. Jour. 1873

also Chloroform, and speedy delivery with forces if necessary. After delivery he recommends that the uterus be not stimulated to contract, and, if sufficient hæmorrhage does not occur, even to open a vein. As soon after delivery as possible he injects as much as 700 c.c. of salt solution under each mamma, and continues this at intervals of three or four days. Dr Jardine of Glasgow[1] has had extended experience of saline infusion in this condition, and his results are a strong recommendation for its use. He proceeds on the assumption that the fits are caused by toxic substances in the blood which should be eliminated by the kidneys. The indications are to produce purgation diaphoresis and diuresis. These at an early stage may prevent the

[1] British Med. Journal 1899. II p. 18.

nervous repression. After the fits come on diuresis is best brought about by subcutaneous injection. The solution he used at first was a drachm of a mixture of one part bicarbonate of potash, and three parts of common salt to the pint of sterilized water - the potash being added for its diuretic action. Later, on the advice of Prof. Stockman, acetate of soda, as being less toxic, was substituted for the Pot. Bicarb. His conclusions are that there is a decided increase in excretion of Urea and of uric acid, and that probably other toxic matter was washed out.

Reporting in 1895 of eight cases of Eclampsia in Glasgow Maternity Hospital, three treated by saline injection recovered - all the others died. Later, in 1900,[1] reviewing

1. Brit. Med. Journal. 1900. I p. 1279.

a series of twenty five cases the actual number of deaths was five which compared favorably with that of other methods of treatment. From peculiar circumstances in one case he claimed that the rate should be stated as four in twenty-two cases, and it had to be remembered that many of these cases were extreme, having had convulsions for hours before admission to Hospital. He recommends that post partum haemorrhage should be managed.

Dr. Munro Kerr in 1907[1] collected all the cases treated in Glasgow Maternity Hospital during the previous fifteen years – 80 cases in all – and found that, prior to the introduction of saline infusion, the mortality was 47%, after. After the introduction the death rate fell to 24%.

[1] Brit. Med. Journal, 1907 I p 1144

There is a useful discussion of the whole subject, in a paper read by Dr. E.W. Hey Groves before the Obstetrical Society of London, in 1901[1].

A striking case of severe Post-partum Eclampsia treated by two infusions is reported by D. Geo. St Johnstone[2]; and a case by D. Nutting S. Fraser[3], where rectal and intravenous infusion were practised before delivery.

Uræmia. Cornet[4] published a case of Eltz, of hemiplegia in which the urine contained albumen. Rectal infusion of one litre of saline solution was given, and was retained; free diuresis ensued, and the urine became normal. Cornet, with Eltz, thinks that Salt acts in some special manner as diaphoresis and diuresis counteracting Uræmia, and thus is indicated in Nephritis and Uræmia is non-

1. Brit. Med. Journal, 1901. I pp. 958 & 1144
2. Ibid, 1903. I 1023
3. Ibid 1903, II 1332
4. Brit Med. Journal 1899. I Epit. 130.

: Surgical cases.

In cases of nephritis with Uremia blood letting has often a beneficial effect, and the operation gives a favorable opportunity for saline infusion. A quantity of toxic material will be got rid of directly by the bleeding, and the saline fluid will largely dilute what remains, and also, by virtue of its diaphoretic and diuretic action, will make for its more rapid elimination. Dr. Glynn[1] reports a case of Nephritis treated vainly by purgation, diaphoretics and diluted milk diet. Uremia came on, and Convulsions developed. Two pints of blood were removed, and one pint of saline was infused into the axillary subcutaneous tissue, followed by half a pint rectally. Convulsions ceased, consciousness returned and free diuresis was established. Previous to

[1] Brit. Med. Journal 1901. I p. 213 & Med. Annual, 1903 p. 474

infusion twenty ounces of urine were the daily maximum. On the day after infusion forty six ounces were passed, and, during the following ten days, an average of seventy ounces. Recovery was complete in about a month.

The writer had a somewhat similar case in a child 9½ years of age, treated without bleeding. The child was comatose when he was called, and coma persisted for eleven days. On the eleventh day convulsions set in and recurred at intervals for four days; and on each day particularly being repeated about every ten or fifteen minutes. At the outset purgation by Elaterium, and diaphoresis by means of Pilocarpine, and by hot packs, and hot air were tried, but the latter was not very satisfactorily produced. No urine was observed to be passed, though there

9½ years.

may have been some in the midst of the hot packs, and only small quantities could be obtained by the catheter; they contained blood abundantly. When the convulsions were at their greatest Chloroform was administered at intervals for three hours. At this stage Saline infusion was resorted to, a pint and a half of hot fluid being injected rectally, and there was immediate response in improved diaphoresis and diuresis; the quantity of urine increased, and the amount of blood diminished. From this time, too, convulsions decreased in number and in severity. The infusion was repeated next day, and coma became less profound, the patient being able to swallow when a vessel was applied to the lips; and thence forward large quantities of hot diluted milk, and of plain warm water were administered by the mouth.

The degree of coma became gradually less until complete recovery. There was amaurosis for a fortnight after regaining consciousness, but this also was ultimately completely recovered from.

Diabetic Coma. Treatment of this condition by saline infusion, though indicated on similar theoretical grounds - dilution and excretion - has not been very encouraging. Roget and Balvay[1] report a case where urine was scanty and oedema present, in which fourteen pints were infused in five days, 3½ directly into the veins, and the remainder subcutaneously. Besides this three rectal infusions of 17½ oz each were given. Free diuresis was established, coma disappeared, and the patient lived for four months. One might be inclined to look upon this as primarily a case of Nephritis with coincident Glycosuria, but post mortem the pancreas was found to be partially

[1] Brit. Med. Journal, 1899, 1 Epit. 143.

absent, and although there was a calculus and pus in the pelvis of the kidney, the kidney substance was quite healthy. The same observers collected records of nineteen cases, but only one recovered from coma.

Having regard to the diminished alkalinity of the blood, and the supposed dependance of symptoms upon poisoning by Beta-oxybutyric acid, the antacid treatment with bicarbonate of soda intravenously was recommended by Stadelmann.[1] Naunyn and Magnus-Levy are quoted by Osler[1] as having had cases of recovery, and he himself reports one. Next to the antacid, he recommends normal saline solution, but improvement is only temporary.

Dr. David Young[2] reports a case which, though terminating fatally, responded well to repeated infusions. During eleven days, 210 oz. of fluid were infused, including 75 drops of Liq. Sodæ, and

[1] Osler. Principles & Practice of Medicine. 4th Ed. pp. 431.

[2] B. M. J. 1903-I pp 544

twelve ounces of blood were withdrawn. At the necropsy death was shown to be due, apparently, to pericarditis.

Septicæmia. Osterneyer[1] reports a bad case after abortion treated by small subcutaneous injections continued for a fortnight. On Dec 14th, 300 grams of saline were injected into the cellular tissue of the infra clavicular fossa when the patient was in a desperate condition. This was repeated on the 15th when the patient began to improve, vomiting and diarrhœa ceasing, and the pulse, which previously was too feeble and rapid to be counted, becoming strong and dropping to 108. Urine, previously scanty, began to be secreted freely. From the 16th till the 20th two subcutaneous infusions were given daily, and one each on the 21st and 22nd, the patient being quite well by the 21st. It is noted that the first infusion on the 14th was not absorbed till next morning, although good effects were perceptible. Later injections were absorbed in 3 hours.

[1] Brit. Med. Journal, 1899. 1 Epit 290.

Calderini[1] reports three cases of puerperal infection similarly treated, two recovering and one dying in a few hours without even temporary improvement.

Osteomyelitis. Recovery in a severe case with depression, collapse, profuse diarrhoea, and haemorrhagic eruptions is quoted in the Medical Annual 1904. p 21.

Mental Diseases. The grouping of these diseases amongst conditions likely to be benefited by saline infusion depends on the belief which is becoming ever more clearly established that they mostly arise from some form of auto-intoxication, and that the peccant toxins may be eliminated by means similar to those used in other Toxaemias. Sir Dyce Duckworth[2] gives the toxaemic states as three-fold in origin; (a) by autointoxication (b) by invasion from without & (c) through habits such as chloralism leading to depraved metabolism. The temporary mental aberration of other acute diseases, and states of a clearly toxaemic character, some

1. B. M. J. 1901. i. Epit 64. 2. Brit. Med. Journal 1900. ii. p 1526.

of which may terminate in permanent mental alienation, also lend weight to this view of the matter. Such temporary conditions prevail in the delirium of Pneumonia and of the infections fevers generally; in puerperal insanity; and in post operative infectious states. Aberrant cerebration, due to autointoxication is sometimes seen in gout; in some degree in Enteric fever; and in acute Chorea, depending on rheumatic toxæmia. Mental deterioration too is a common observation in the abuse of hypnotics, morphia, chloral, or cocaine; the effects being partly direct, and partly through interference with metabolic processes.

Dr. J.R. Gilmour[1] has pointed out the value of Saline infusion. The rectum is first emptied, and about 15 oz of saline is introduced three or four times daily. Constipation, with consequent absorption of stercoraceous toxic material, is a common accompaniment of mental disorders, and its correction has a

[1] Brit. Med. Journal 1904. i. p. 958.

generally ameliorative effect. No bad results have been observed from the injections. A practical point in such cases is to observe closely the condition of the bladder, so as to obviate retention of urine.

S. W. Ford Robertson[1] in the Section of Psychological Medicine of the Brit. Med. Assoc[n] in 1901, contributed a paper on "The Rôle of Toxic action in the pathogenesis of Insanity", a perusal of which convinces me that elimination of toxic material is the essential in the greater number of cases, and Saline injection is a rational method of securing, or at least helping, in that elimination

Pneumonia. Osler,[2] from his experience of the use of subcutaneous saline injection in this disease, is favourably impressed with the results where cardiac weakness is prominent. He injects two pints slowly.

Cunningham[3] was similarly impressed.

1. Brit. Med. Journal 1901. II p. 1230. 2. Princ. & Pract. of Med. p. 137
3. Mid. Annual 1895. p. 428.

in cases suffering from apparent cardiac failure. He believes that the increased excretion of Chlorides in Pneumonia has much to do with the cardiac failure, so that substitution by Saline is rational. When the right heart is hampered we might well pause before adding further fluid to the circulation, but, as we have already seen, blood pressure is not increased by infusion except momentarily, & that chiefly when the intravenous method is practised, whilst the viscosity of the blood is markedly diminished and the rapidity with flow increased, & therefore the Oxygenating power of the corpuscles increased also. We know bloodletting is sometimes of marked benefit in these cases of right cardiac embarrassment, and bloodletting may be combined with infusion, but the writer would advise, even when Venesection

has been performed, that the subcutaneous or rectal route should be chosen, thus avoiding even a momentary rise of blood pressure.

Hewry[1] as the result of several years experience does not consider blood-letting necessary with saline infusion, Drs Ewart and Beaumont Percival[2] have given a detailed report of five hospital cases chosen for treatment by saline infusion because of their gravity. There were four deaths, and this on the face of it does not much recommend the treatment. But a close analysis of the cases led to a belief that (a) there was no unfavourable results (b) the fatal end was delayed (c) the infusions were comforting to the patient, and, on the whole, (d) the effects produced warranted further trial in cases of grave prognosis.

Hyperpyrexia. Dr Lord[3] reports a complicated case

1. Med. Annual, 1904. p 21.
2. Brit. Med. Journal 1900 - II p. 900
3. Brit. Med. Journal 1902 - II p 1878

where symptoms arose suggestive in turn of Influenza, Osteomyelitis or abscess of humerus, Typhoid, Typhus, and Scarlet Fever, & in whom the temperature reached 111·5°F. In the course of the case collapse was overcome by subcutaneous infusion of one pint of Saline fluid on two occasions.

The case recovered

The writer has experience of a case of Heat stroke occurring during passage of the Red Sea in which a temperature of at least 111°F was attained, and in which the rectal injection of cooled sea water was part of the treatment, ending in complete recovery. The following is a brief abstract of notes made at the time.

T. C., age 20, Pantryman. At 5 p.m. came complaining of feeling "Shaky". Pulse 84. Temp 101·5. Given Quin Sulph gr 2 and ordered to rest. About 7 p.m. was called

to T.C. as he was reported to be dying. He was half lying half sitting in the forward hatch, breathing laboriously, and only semi conscious. The skin was burning hot and dry. Temp. 111°F. at least (writing Thermometer not registered only to that point) Pulse 148. In about three minutes patient lapsed into complete unconsciousness. He was stripped; ice was applied to the nape of the neck, ice water cloths to the head, & the body and limbs sponged continuously with iced water. Hypodermics of Strychnine and Digitalis were given. In about half an hour temperature dropped to 106°F, at which it remained till 9.30 pm. ~~having been~~ being taken every few minutes. At that hour there was a copious discharge of dark brown fluid faeces of extremely bad smell. This suggested to the writer's mind the introduction of fluid, and about two pints of sea water

cooled with ice (as has been used for stomping externally) was injected rectally. It was retained and the temperature at once began to fall, at 10 pm being only 103°F, with pulse 100 & respirations 28. During this time the pupils behaved curiously, alternating between the pinhole condition, and that of extreme dilatation. When dilated they responded feebly to light stimulus. About 10 pm. the patient had a general convulsion, beginning with rhythmic movements of the feet and hands, rapidly involving the whole body, & necessitating control by several assistants to prevent patient falling off the bench. The temperature after the first convulsion was 103.8°F and it fell in fifteen minutes to 102.8°F Convulsions were repeated every half hour till midnight - four in all, the last winding up with vomiting. During convulsions

the pupils were dilated, and there was squint to the left side.
Shortly after 12 pm. the patient became conscious, recognising those around him.
Temperature 103° F. Pulse 88
2 am. Patient asleep. Resp. regular
Temp. 102·8° F (taken without awaking him)
3 am. awake. Quite sensible. Headache. Drowsy. Temp 102° F
8 am. Felt much better Temp 102° F
9 am. Temp 101·8° F. 12 noon 100° F.
4 pm. Temp. normal.
Kept on milk diet, & resting all this day.
Two days after the patient resumed work, and for two and a half months thereafter, until he was last night, enjoyed his usual good health.

Mushroom Poisoning. Delobel[1] records a case of profound collapse from eating mushrooms. The pulse was extremely feeble, and only 28 per minute, and the respirations were of the Cheyne-Stokes type.

1. Brit. Med. Journal, 1900. 1 Sept. 52

Hypodermic injections of Atrop. Sulph. and of Ether were given, whilst rum and coffee were given by the mouth, and hot water bottles applied externally. These measures were ineffectual, collapse becoming more extreme, and the pulse sinking to 24 per minute. Finally one litre of salt solution was infused into the thigh with immediate good effect. In a quarter of an hour the pulse rose to 30, and at the end of an hour the rate was 60, lineim was good, respiration was regular, and the patient out of danger.

Alcoholic Poisoning. Mr Frederick C. Foster[1] reports acute poisoning in a child four years of age by drinking two ounces of "neat" whiskey. The child was profoundly collapsed. The stomach was emptied with a stomach tube, and repeated hypodermic injections

1. Brit. Medical Journal 1903. I. p 1142

of Strychnine and Digitalis were administered, but with little or no apparent good effect. Resort was then had to warm saline per rectum. About one pint was injected, and most of it was retained. In half an hour the patient had rallied sufficiently to take some hot beef-tea by the mouth. Recovery was rapid & complete.

Morphine Poisoning. Dr. E. J. Willoughby[1] successfully treated a case in which 8 grains of Morphine Sulphate had been taken within half an hour. Hypodermic injections of atropine and of strychnine, artificial respiration, and Electric Stimulation had been employed in vain, and the Case seemed to be sinking. Thirty ounces of Saline fluid were injected subcutaneously into the flank with immediate improvement and ultimate recovery.

1. Lancet, May 10. 1902

The writer had opportunity on one occasion of making equally good effect with two rectal injections of one and a half pints each of warm saline. The case was that of a young woman who had taken a quantity of Laudanum which, according to her own story afterwards, must have amounted to nearly two ounces. Unconsciousness was profound, pupils contracted, pulse small, and respirations shallow and infrequent. With help the patient was propped up, the mouth opened, and the stomach washed out repeatedly by means of a siphon stomach tube. About 8oz of water with 5 grains of Pot. Permang dissolved in it was left in the stomach, and hypodermic injections of Strychnine, and of atropine were administered. These means were repeated, but collapse became more profound, the pulse becoming

imperceptible at the wrist. Artificial respiration was resorted to, and at the same time a pint and a half of warm water with 1½ teaspoonfuls of salt dissolved in it was injected rectally. There was speedy improvement in the pulse, and in half an hour the patient became conscious and passed a quantity of urine. Another pint and half was injected and strong coffee administered by the mouth. Recovery thereafter progressed without interruption.

Dr. Hutchison[1] recommending the treatment of Jaundice in non-surgical cases advises the use of Cold enemata. Intestinal peristalsis is induced & also diuresis. If the enemata consisted of Saline fluid, it is likely that this latter effect would be increased.

From a consideration of all the circum-

[1] Med. Annual 1904. p 457.

of the occurrence of post operative
Acute Yellow atrophy of the Liver[1],
he concludes that "it is caused by
infective processes with the help of
the toxic influence of Chloroform."
The latter facts he puts forth tenta-
tively. One can be successfully
treated by venesection followed by
intravenous saline infusion.

In conclusion, and to sum up, we may
say that in principle saline infusion
is thoroughly physiological; that in practice
the methods which may be employed
are such as will suit most diverse cases
in the rapidity with which they may
be applied; and that for a mode of
treatment of such undoubted power it
is comparatively safe, and little liable
to untoward result. It is not advised
that the operation should be undertaken

[1] Med. Annual, 1904. pp. 491.

lightly, or without sufficient cause. But in a great number of cases, where the ordinary means of treatment are uncertain or fail in their object, we have in saline infusion a potent auxiliary, whose effect we can fairly well gauge and whose action we can closely control by the extent, to, and frequency with which we employ it. It is not claimed that it is a certain remedy in all cases in which its use is recommended; but, wherever the heart's action is hampered for want of vital fluid; wherever toxic substances are circulating which require elimination; wherever the nerve centres are benumbed from extrinsic or intrinsic causes, we have in Saline infusion a powerful agent, and one which gives us a ray of hope in desperate cases: for even if complete recovery be not the result, a brief extension of life, and an amelioration of the patient's

condition are likely to attend its use.

J. Dixon.